Stability of accretion disks

Ranjeev Misra

Inter-University Center for Astronomy and Astrophysics (IUCAA)
Pune, India

Agneiska Januik (Centre for Theoretical Physics, Warsaw, Poland)

Standard Accretion Disk Theory

- The standard accretion disk theory (Shakura and Sunyaev 1973) has been broadly successful in explaining the thermal component seen in X-ray binaries.
- In the model the viscous stress is taken to proportional to the pressure f = alpha * P, where P = P_gas + P_radiation

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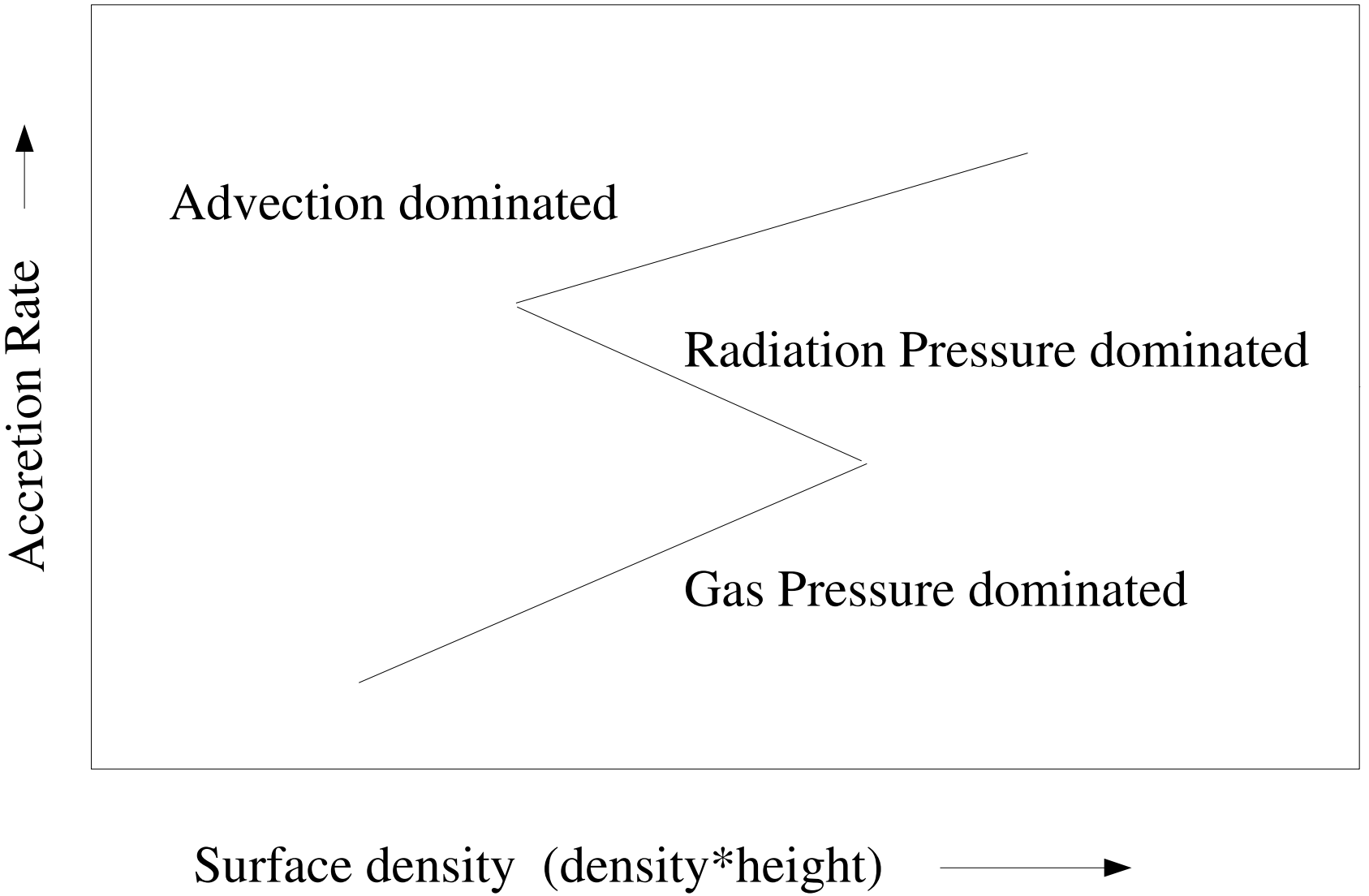
- In the model the viscous stress is taken to proportional to the pressure f = alpha * P, where P = P_gas + P_radiation
- If radiation pressure dominates (i.e. > 5% of Eddington rate) the disk is unstable.

Accretion rate – Surface density relation



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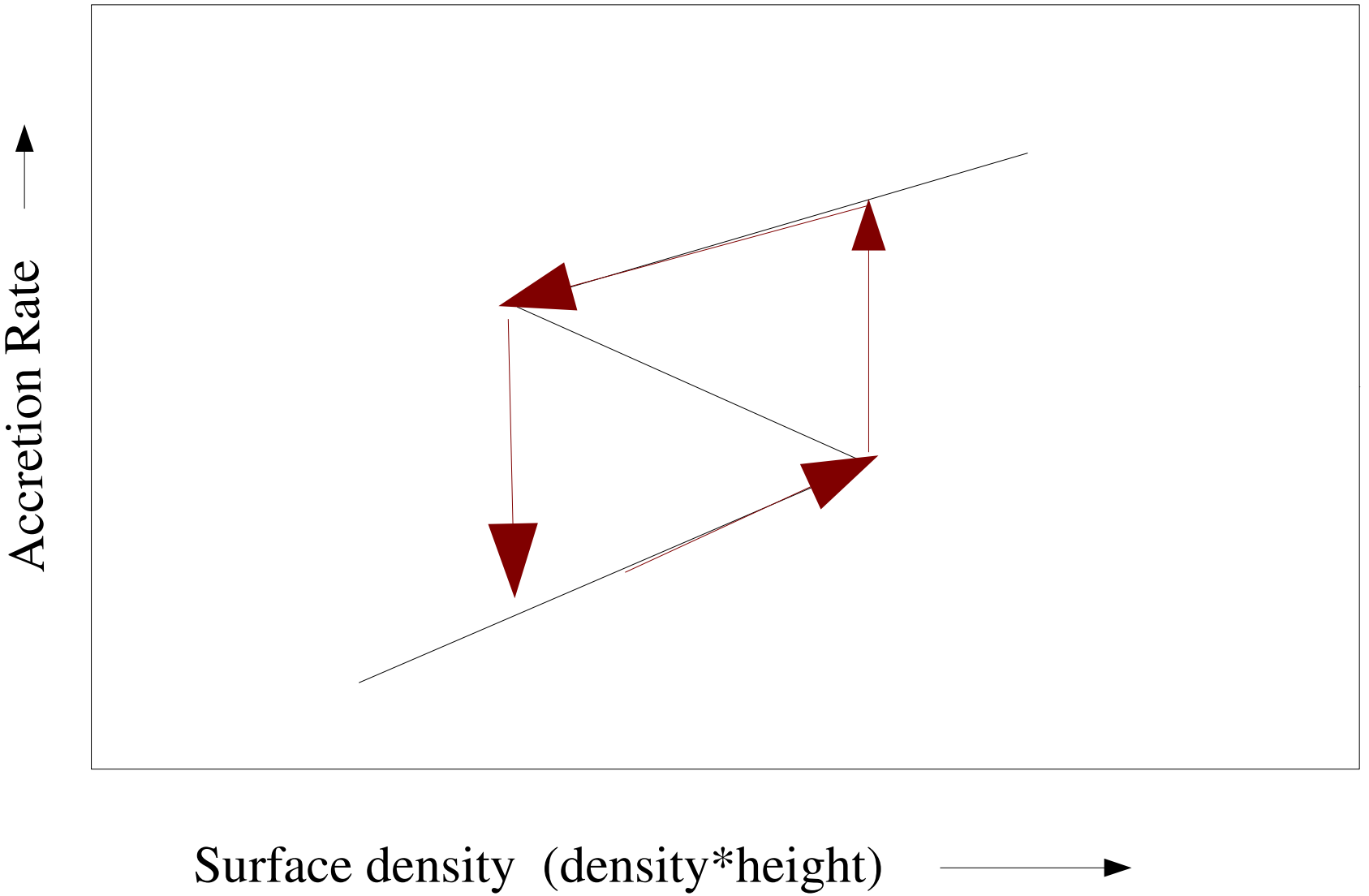
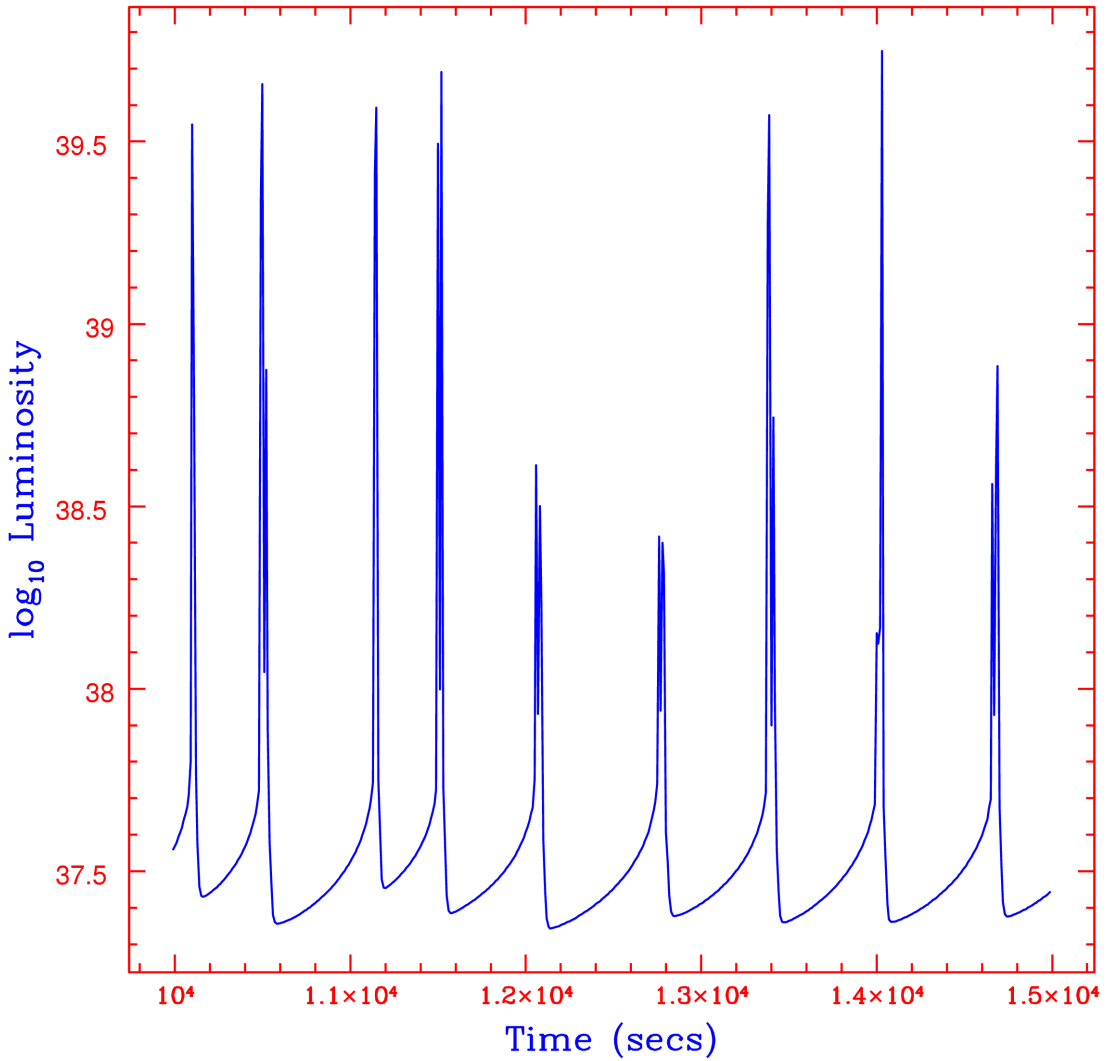


Light Curve of RP unstable disk



Possible Solutions:

- Maybe the viscous stress scales only with the gas pressure and not the total pressure.
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- Combination of both –GRS 1915+105 (e.g. Januik & Czerny 2011, Nayakshin 2005)

Variability of Black Hole systems

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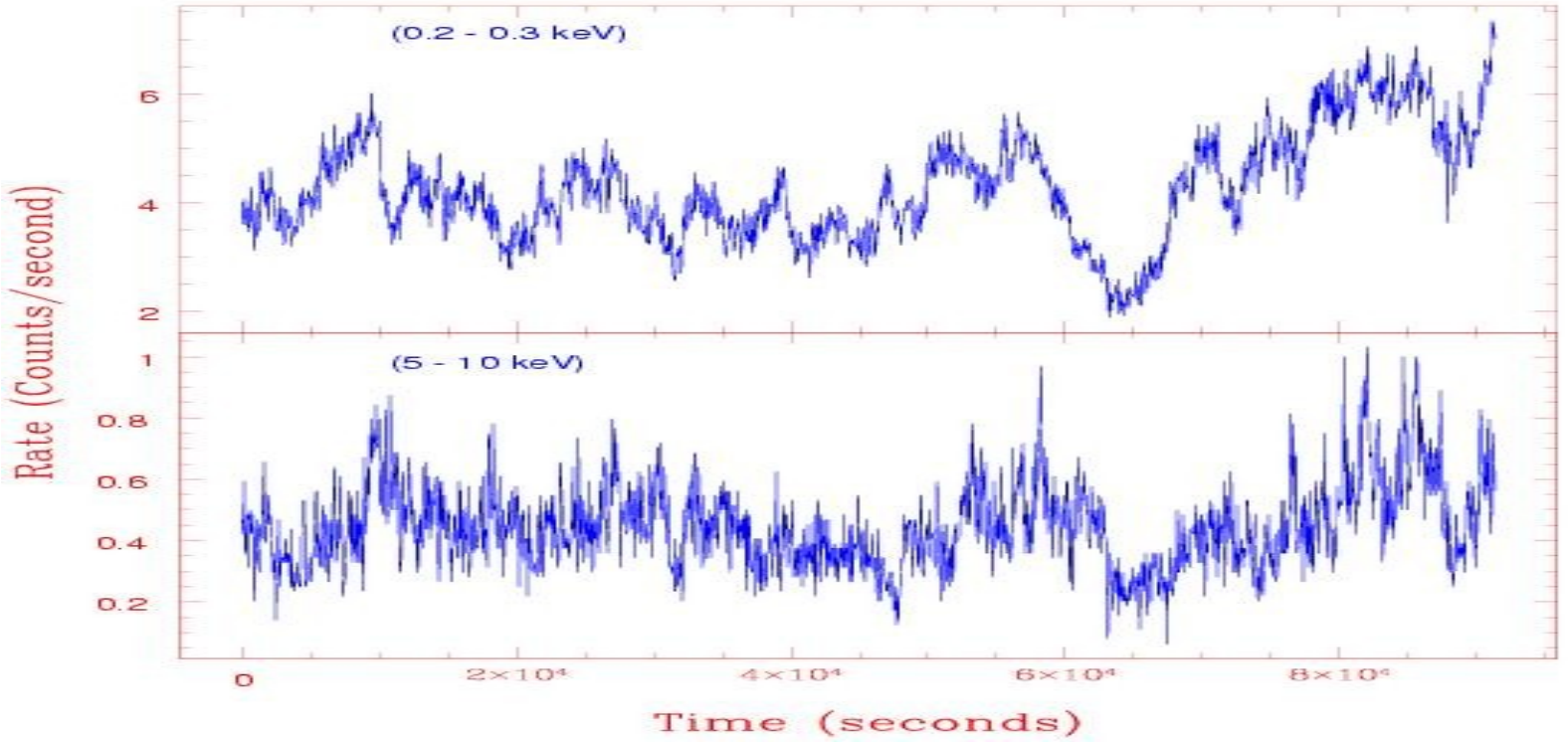
Typical light curve of an AGN



Variability of Black Hole systems

- Black hole systems (both X-ray binaries and AGN) show stochastic variability.
- This variability maybe due to the viscous fluctuation model (Lyubarskii, 1997)
- Here alpha is assumed to vary stochastically at every radii at the local viscous time-scale
- The local accretion rate fluctuations propagate to the inner regions producing luminosity variations in different timescales.

Variability of Black Hole systems

- The viscous fluctuation model may explain several properties of AGN/X-ray binaries
  - Power spectra $\propto 1/f$
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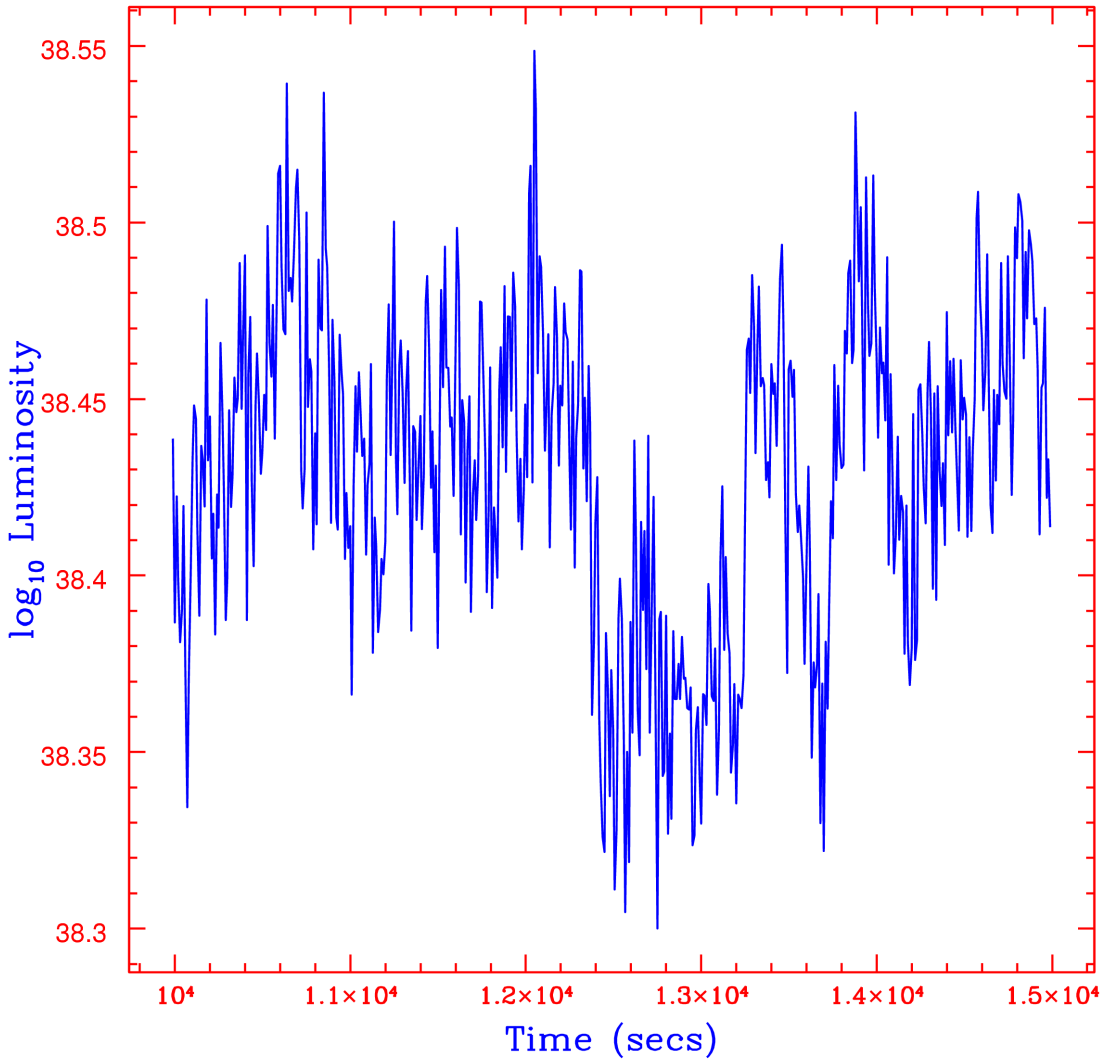
- The viscous fluctuation model may explain several properties of AGN/X-ray binaries
  - Power spectra $\propto 1/f$
  - r.m.s vs flux
  - Energy dependent time-lags
- What is the effect of viscous fluctuations on the Radiation pressure instability?

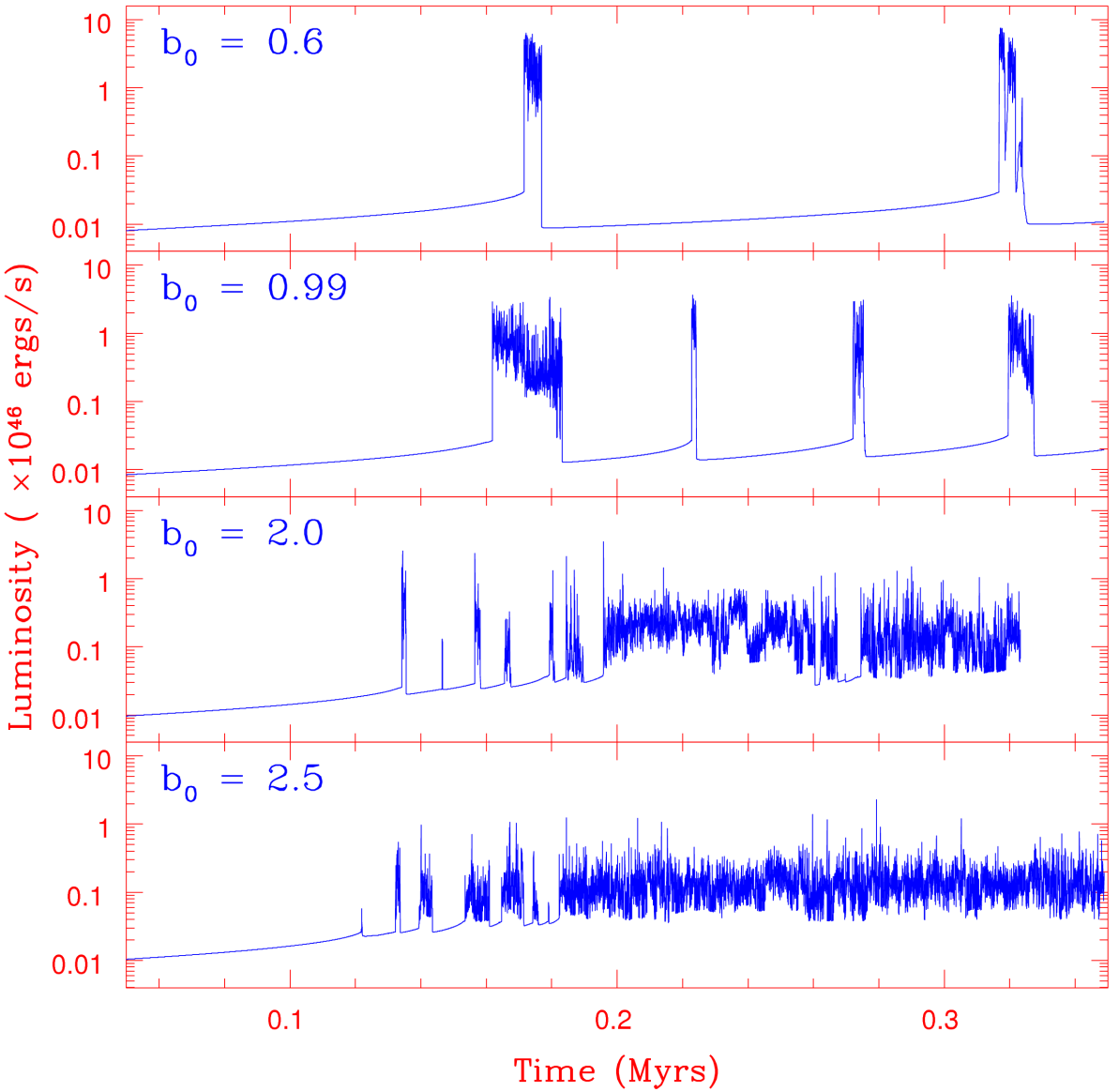
Simulation of stable disk

F = alpha * P_gas

Power spectrum ~ 1/f



Simulation of RP disk with viscous fluctuations



Variability of Black Hole systems

- Viscous fluctuations may stabilize radiation pressure dominated standard accretion disks
- Need to consider a specific source and compare simulated lightcurve with the observed one. In particular is the r.m.s consistent or does one need to consider some energy loss to corona/jet?
- A theoretical (non-linear!) understanding of why these fluctuations stabilize RP disks?